An Analysis of the Gulf of Mexico Greater Amberjack, *Seriola dumerili*, Stock Condition

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ABSTRACT

The Gulf of Mexico greater amberjack stock condition was analysed using data on commercial landings, recreational and headboat catches, and length samples collected since 1987 from Florida through Texas. Estimated annual combined commercial and recreational catches of the Gulf of Mexico greater amberjack peaked in 1989 at about 800,000 fish and 14 million pounds. Landings were mainly off the west coast of Florida and Louisiana. Commercial landings were from 15 to 40% of the estimated total annual landings. Recreational catches of greater amberjack declined by about 88% from 1989 to 1995 while commercial catches declined by about 91% in numbers and 39% in weight. The estimated age composition of the commercial catch was mainly fish ages five or less with older fish occurring rarely. Recreational and headboat fishermen caught fish mainly ages two through four. Age one fish were caught mainly by headboat anglers. A shift in the age structure of the catch to older fish occurred with the implementation of recreational and commercial minimum size limits in 1990. ADAPT VPA analyses indicate fishing mortality on adult fish, ages 4+, was about 0.8 in 1988 and 1989 declining in 1990 by about 50%. Estimated spawning potential ratios computed using ADAPT VPA results through 1994 indicated the Gulf of Mexico greater amberjack stock is not over-fished.

KEY WORDS: Greater amberjack, Gulf of Mexico, *Seriola dumerili*, virtual population analysis, stock assessment

INTRODUCTION

In earlier studies McClellan and Cummings (1996) and Cummings and McClellan (1997) documented the Gulf of Mexico greater amberjack, *Seriola dumerili*, fishery and reported on the abundance decline observed in the middle 1990's by headboat fishers in Florida. Headboat anglers in particular noted the disappearance of large fish from the catch, however, commercial fishermen were not observing a similar decline. Fisheries' managers responded to the questions raised by recreational anglers and initiated a series of workshops and public

hearings in Florida during 1996. In addition, the recreational industry requested that federal managers conduct an evaluation of the stock since the major portion of the fishery occurred in federal waters.

This paper extends the description of the Gulf of Mexico greater amberjack fishery given in McClellan and Cummings (1997) and describes the results of ADAPT Virtual Population Analyses (VPA) (Powers and Restrepo, 1992) used to evaluate the stock status of the Gulf of Mexico greater amberjack. The VPA analyses of McClellan and Cummings (1996) are extended. These analyses incorporated the recreational catch, commercial landings, biological samples, and the catch per unit of effort (CPUE) databases developed in earlier studies and updated subsequently in Cummings and McClellan (1997).

DATA SOURCES AND METHODS

The fishery bio-statistical databases described in Parrack (1993), McClellan and Cummings (1996), and Cummings and McClellan (1997) were the basis for the analyses made in examining the condition of the Gulf of Mexico greater amberjack stock. These data included commercial landings in weight from 1962 through 1995, estimates of the numbers of fish caught by recreational charterboat, private boat and headboat anglers from 1981 through 1995, observations of individual length, and standardized catch per unit of effort abundance trends from 1981 through 1995 from the recreational fisheries and from 1992 through 1995 for the commercial fishery. Bio-statistical samples of length spanned the years 1983 through 1995 for the commercial fishery, 1981 through 1995 for the recreational (charterboat, private, shore), and 1986 through 1995 for the headboat fishery.

The greater amberjack estimated recreational catches and reported commercial landings data were assigned to stock groups as described in McClellan and Cummings (1997). Two stock groups were assumed as described in the Gulf of Mexico and South Atlantic federal reeffish management plans for greater amberjack, the Gulf of Mexico and the South Atlantic stocks. Commercial landings reported as caught in NMFS statistical reporting grids' 002.0 - 021.0 were included in the Gulf stock. Commercial landings reported as caught in grids' 001.0 and 001.2 were excluded from the Gulf stock. All commercial landings for 1994 and 1995 reported in Florida from Monroe county were excluded from the Gulf stock. Relatively low exchange occurs between the two stocks suggesting the current management unit definitions are appropriate for stock separation (McClellan and Cummings, 1997). Estimated total number of fish caught by commercial fishers were calculated using reported landed weight and samples of size, according to procedures outlined by McClellan and Cummings (1996) and Cummings and McClellan (1997). First, commercial landed weight was converted to catch in numbers by dividing total landed weight

by the sample average weight from a matching catch length frequency sample that was selected from the same year and fishery (commercial or headboat, or recreational) of catch. Sample average weight was calculated for each separate length frequency sample using the weight to length conversion formula of Manooch and Potts (1997). Estimated total numbers caught were apportioned over length according to the pooled year and fishery specific length frequency sample which was developed using by weighting each separate length frequency by the sample size. Incomplete within year sampling precluded using month as an additional stratification in assigning samples to catches so length samples were pooled across months within a year and fishery. The resulting catch at length distributions (Cummings and McClellan, 1997) were converted to annual catch at age distributions using the inverted form of the von Bertalanffy growth equation (Beasley, 1993).

The ADAPT VPA method (Powers and Restrepo, 1992) was used to obtain statistical estimates of population parameters for the Gulf of Mexico greater amberjack stock. Very few fish were sampled for length in the commercial fishery prior to 1987 ($n < 500$ fish) therefore the VPA baseline trials only included catch data from the years 1987 through 1995. The method as described in Powers *et al.* (1996) derives statistical estimates of population parameters using nonlinear least squares in an estimation process that fits observed indices of abundance to population estimates generated by the model from cohort analysis for specific age groups as:

$$\min_{\mathbf{p}} LS = \Sigma_{it} [X_{it} - q_i \Sigma_j (B_{ijt} N_{ijt})]^2$$

where:

$\mathbf{X}$ is the index $\mathbf{i}$ in year $\mathbf{t}$

$\mathbf{N_{ijt}}$ is the abundance in year t of the $\mathbf{j}$ ages represented in index i

$\mathbf{B_{ijt}}$ are appropriate conversion factors for that index i and age j (for example, conversion from numbers to weight, of abundance from the beginning of the year to midyear, or conversion of selectivity by age within the age group). The scaling parameters $\mathbf{q}$ are found in the Least Squares (LS) estimation and the population parameters, $\mathbf{p}$ are the key parameters to be estimated.

The abundance trends, were the standardized CPUE indices from McClellan and Cummings (1996) and Cummings and McClellan (1997), which existed for recreational charter, private boat, and shore anglers from 1981 - 1995 from the Marine Recreational Fisheries Fishing Survey (MRFFS), from 1986 - 1995 for headboats, and since 1992 from commercial reefish logbooks. CPUE data used

to develop the MRFSS abundance index included fish released. Annual standardized abundance trends were calculated using general linear regression methods (Robson, 1966) that incorporated information on the time period of the catch (month, season), the area of fishing (i.e., state of landing was used as a proxy), and the type of fishing activity (charter, private, shore) to reduce the amount of unexplained error in observed CPUE.

FISHERY BACKGROUND INFORMATION

McClellan and Cummings (1996) and Cummings and McClellan (1997) described trends in commercial landings and recreational harvest of the Gulf of Mexico greater amberjack stock. Those results are summarized here as background information needed in addition to the ADAPT VPA results for evaluating Gulf of Mexico greater amberjack stock status.

Commercial landings ranged from 5,616 lbs (1965) to 2.3 million pounds (lbs) (1988) over the 34-year period, 1962 - 1995 (Cummings and McClellan, 1997). Landings increased explosively in the early 1980s to 2.3 million lbs in 1988 and declined by 51% to 1.1 million lbs in 1990. Declines in landings were largest on the Florida west coast and off Louisiana (Figure 1). The 1995 reported commercial landed weight was 0.9 million lbs., 39% lower than reported in 1992. Most commercially caught greater amberjack were taken from areas east of the Mississippi River (Figure 2a,b). Hook and lines were the primary gear used to catch greater amberjack with 71% of the total landed weight taken between March and August, the time period assumed to be associated with spawning (Cummings and McClellan, 1997).

Estimated total annual recreational (charterboat, private vessel, and headboat) harvest of the Gulf of Mexico greater amberjack stock ranged from 61,669 (1995) to 688,011 (1992) fishes with the largest catches coming from anglers in Florida (Cummings and McClellan, 1997). Large variance estimates associated with recreational catches adds uncertainty to analysis of trens in recreational catch. However, the catch data show a consistent declining trend in estimated catch of nearly 90% that began in 1989 and continued through 1995. The decline in recreational catch occurred across all modes with individual sector catch declines of 88% (private angler), 87% (charterboat), and 83% (headboat)between 1989 and 1995. Historically, charterboat anglers landed more greater amberjack than did anglers fishing from private vessels or from for-hire headboats with the headboat fishery catch being less than 10% of the total annual recreational greater amberjack harvest since 1987 (Cummings and McClellan, 1997). Commercial catches remained under 100,000 fishes through 1987 but showed an increasing trend in each year beginning 1983 through the peak year catch, 1988. Thereafter, declining catches were observed in the commercial fishery through 1995, which was 91% lower than the peak year catch of nearly 364,000 fishes.

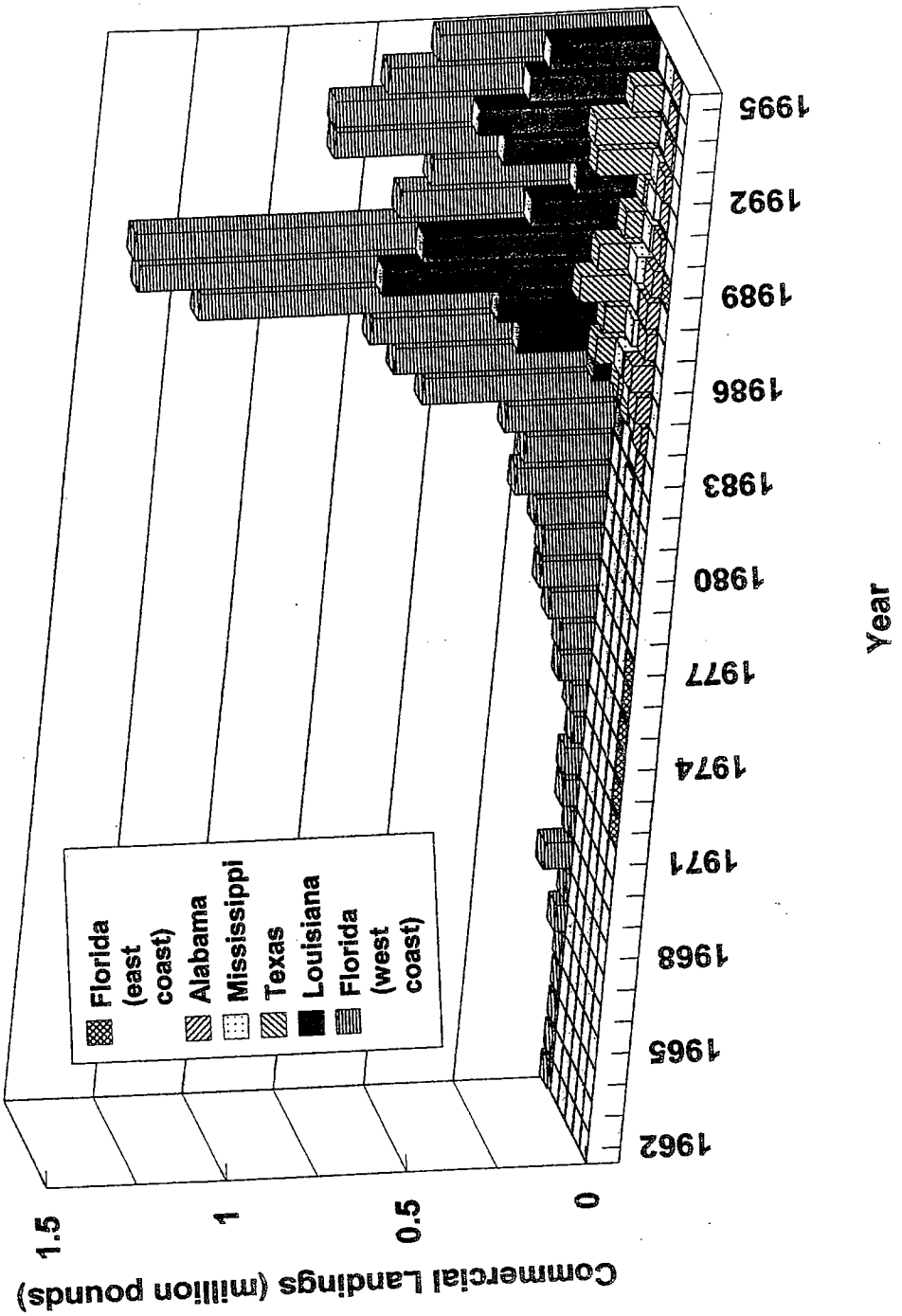
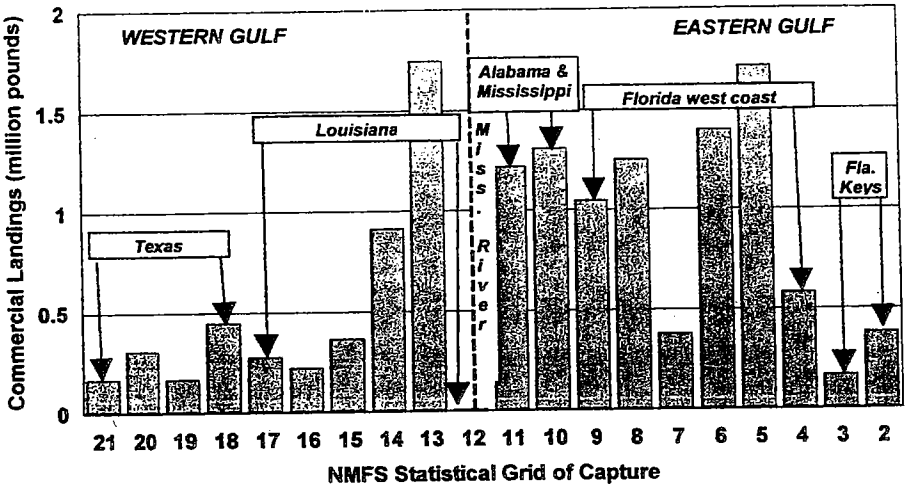


Figure 1. Total reported commercial landings of Gulf of the Mexico greater amberjack stock by state landed and year, 1962-1995.

a)



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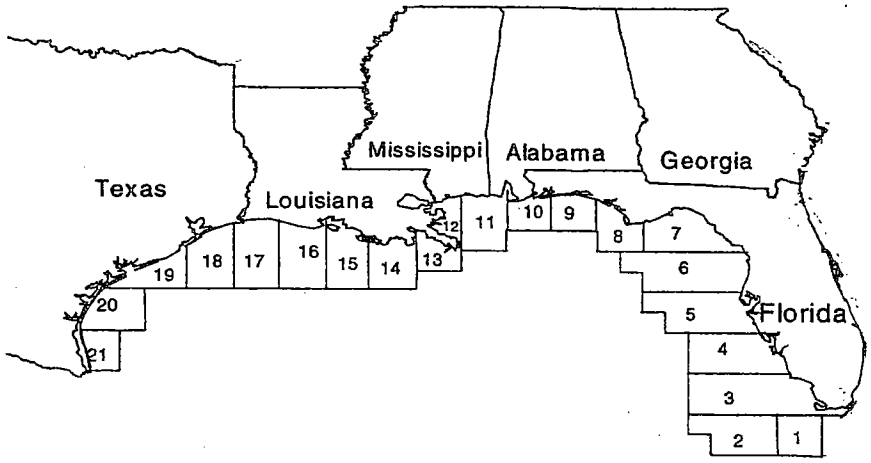

Figure 2. **(a)** Total reported commercial landings of the Gulf of Mexico greater amberjack stock by NMFS statistical reporting grid capture location 1977-1993 . **(b)** Total reported commercial landings of the Gulf of Mexico greater amberjack stock - map showing locations of reporting grids.

RESULTS

Total Estimated Catch at Age and Catch at Length

Length samples of the catch, commercial landings data, and estimated recreational catches were sufficient to estimate the total catch in numbers of fish for the Gulf of Mexico greater amberjack stock from 1981 through 1995 (Table 1). An estimated range of 92,935 (1995) to 793,779 (1989) fishes were caught annually from the combined commercial, recreational, and headboat fisheries. The catch length sampling rate ranged from 0.02% to 1.2% of the catch by number per year with some years having incomplete sampling in all fisheries. Length frequency distributions of the estimated total catch were, developed by applying pooled annual fishery-specific length frequency samples of the reported catch in weight (commercial) or estimated catch in number (recreational, headboat) (Figure 3a-c). Length samples were not available for the commercial fishery for 1981 or 1982 or from the headboat fishery prior to 1986 therefore estimated total catch is incomplete in these years. Catch at age distributions developed from applying the inverted von Bertalanffy growth equation to the yearly fishery specific catch at length densities are given (Figures 4a-c).

Greater amberjack commercial catches were mainly fish of ages 3-6 between the years 1983 and 1989 (Figure 4a). Only in the late 1980's did significant quantities of older fish, ages 6+ appear in the commercial catch. Age 2 fish occurred in large quantities from 1990 through 1994 however, the dominant ages were 4-7+.

In the recreational charter, private, and shore fisheries, ages 2-4 dominated from 1981-1988 (Figure 4b). Recreational catches contained age 6+ fish in large quantities only in a few years, 1988-1990. The catch composition since 1991 has been mainly of ages 3 - 4 with very few age 1 fish occurring in the catch.

The headboat catch at age composition was similar to that of the recreational private, charter, and shore modes, with the primary age groups composed of young fish, ages 1- 4 in 1986-1988 and ages 2 - 4 in 1992-1995 (Figure 4c). Age 1 fish were more dominant in the headboat catch during the early years, 1986 - 1990, than in the recreational catch. In addition, age 5+ fish were caught in only a few years, 1989 - 1991 and 1993 and in very small quantities.

Adapt VPA

CPUE abundance indices were used to fit the Gulf of Mexico greater amberjack catch at age data. These included standardized catch per angler trip for charter, private boat, shore trips made 1981 through 1995 developed from MRFFS data standardized pounds per trip calculated from commercial vessel logbook reports made for 1992 through 1996 to NMFS, and standardized catch per angler day from headboat captain reports from 1981 through 1995 to NMFS. These indices were described in dtail by McClellan and Cummings (1996) and

Table 1. Estimated total number of the Gulf of Mexico greater amberjack stock harvested and sampled by fishery and year. The sampling fraction of the combined fisheries is calculated as the weighted percent of separate fisheries.

* = insufficient data

** = headboat catches included in MRFSS charter/partyboat catch estimates from 1981 - 1985.

*** = NMFS, Headboat Survey extended to the Gulf of Mexico in 1986.

**** = corrected from values reported in Cummings and McClellan (1997)

	Fishery					
	Commercial			Charter, Private & Shore		
Year	Catch (Numbers)	Number sampled	Sampling Fraction	Catch** (Numbers)	Number sampled	Sampling Fraction
1981	*	0		104,284	62	0.06%
1982	*	0		441,692	106	0.02%
1983	14,173	23	0.16%	170,393	111	0.07%
1984	30,104	142	0.47%	77,141	117	0.15%
1985	38,703	291	0.75%	128,619	109	0.08%
1986	54,521	129	0.24%	521,795	294	0.06%
1987	88,640	40	0.05%	635,137	825	0.13%
1988	363,060	749	0.21%	278,899	246	0.09%
1989	185,568	470	0.25%	555,695	544	0.10%
1990	38,036	659	1.73%	62,027	361	0.58%
1991	21,136	761	3.60%	240,813	2,271	0.94%
1992	45,811	917	2.00%	252,889	1804	0.71%
1993	47,092	533	1.13%	171,474	235	0.14%
1994	39,228	791	2.02%	118,546	401	0.34%
1995	31,267	348	1.11%	52,999	112	0.21%

	Fishery					
	Headboat			All Fisheries Combined		
Year	Catch (Numbers)	Number sampled	Sampling Fraction	Catch**** (Numbers)	Number sampled *****	Sampling Fraction
1981	***	4		104,284	66	0.06%
1982	***	30		441,692	136	0.02%
1983	***	321		184,566	455	0.07%
1984	***	162		107,245	421	0.24%
1985	***	32		167,322	432	0.24%
1986	86,022	606	0.70%	662,338	1,029	0.16%
1987	52,880	545	1.03%	776,657	1,410	0.18%
1988	29,654	407	1.37%	671,613	1,402	0.21%
1989	52,516	1426	2.72%	793,779	2,440	0.31%
1990	24,263	238	0.98%	124,326	1,258	1.01%
1991	9,865	189	1.92%	271,814	3,221	1.19%
1992	19,753	388	1.96%	318,453	3,109	0.98%
1993	14,055	245	1.74%	232,621	1,013	0.44%
1994	13,116	256	1.95%	170,890	1,448	0.85%
1995	8,669	277	3.20%	92,935	737	0.79%

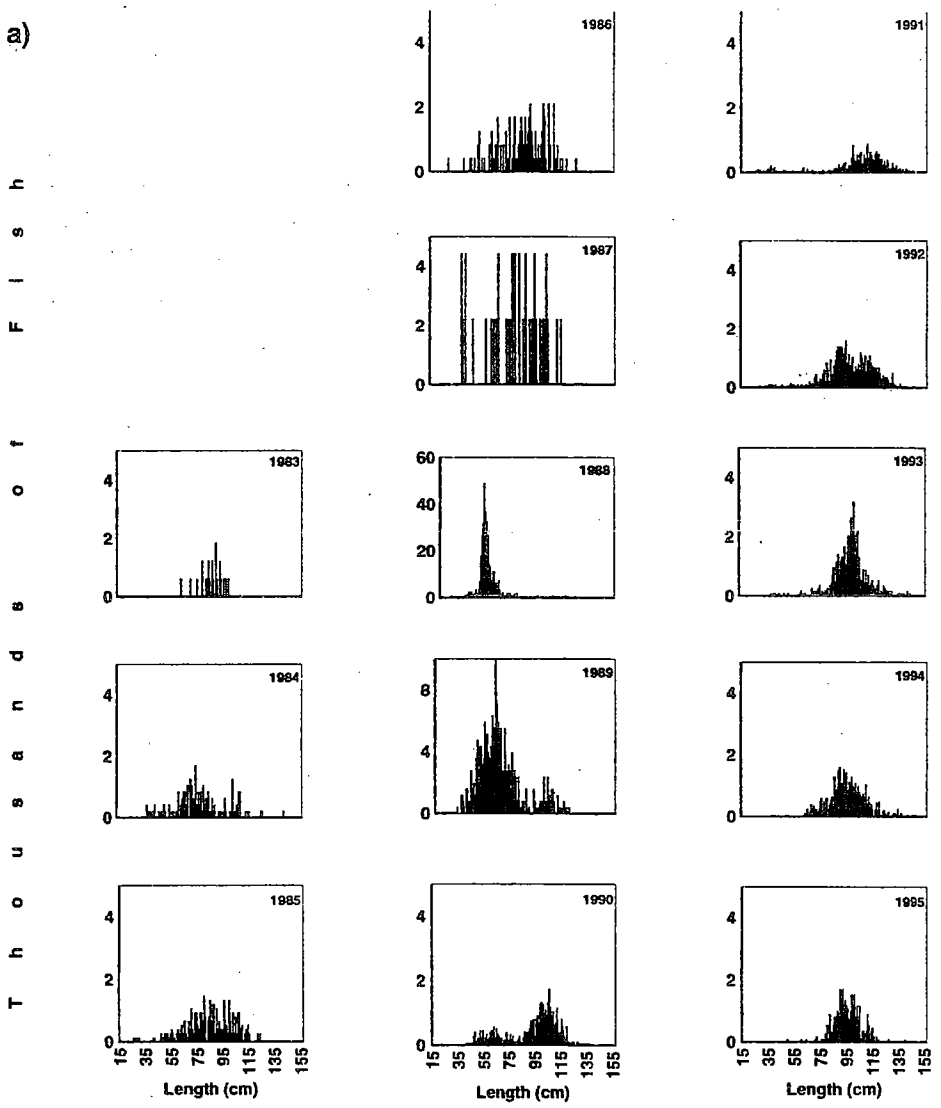

Figure 3a. Estimated harvest of Gulf of Mexico greater amberjack stock by size category and fishery - commercially from 1983-1995,

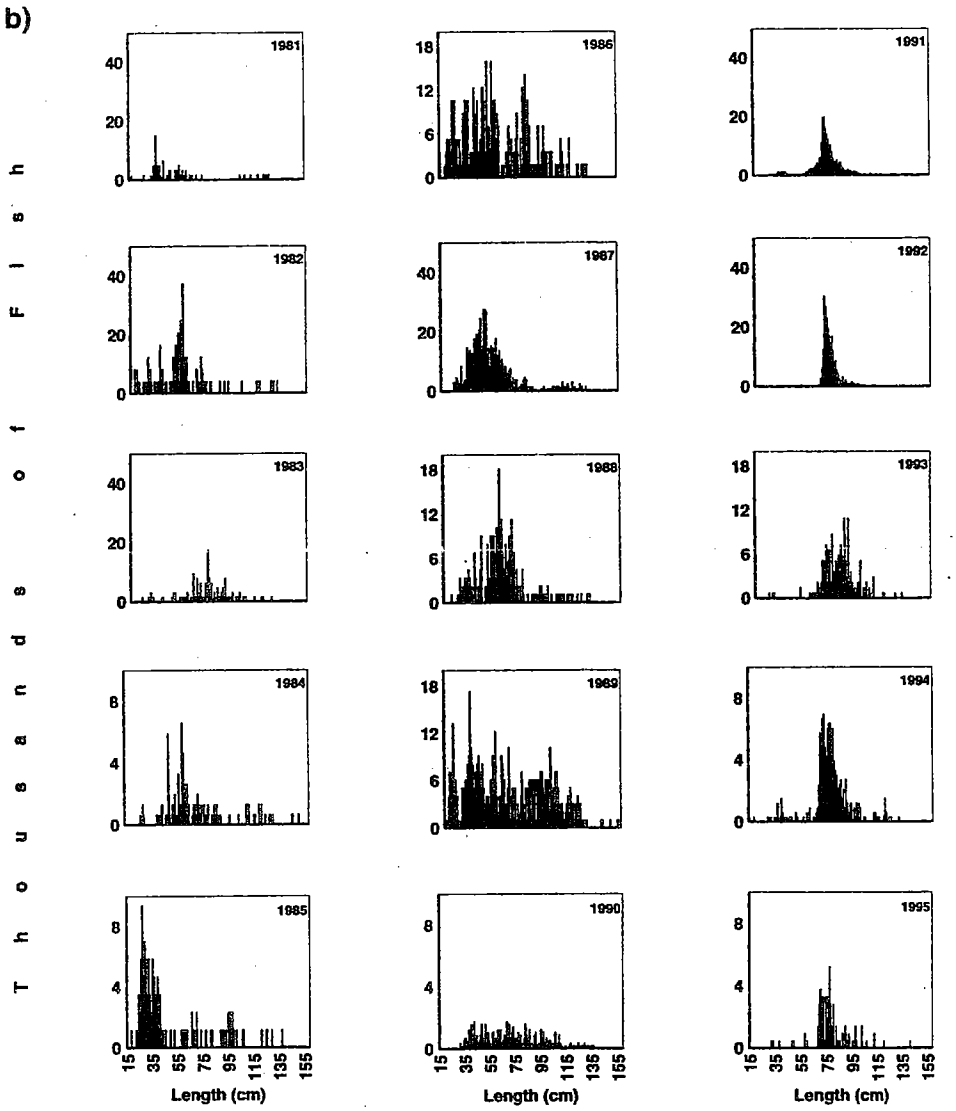

Figure 3b. Estimated harvest of Gulf of Mexico greater amberjack stock by size category and fishery - recreationally from 1981-1995.

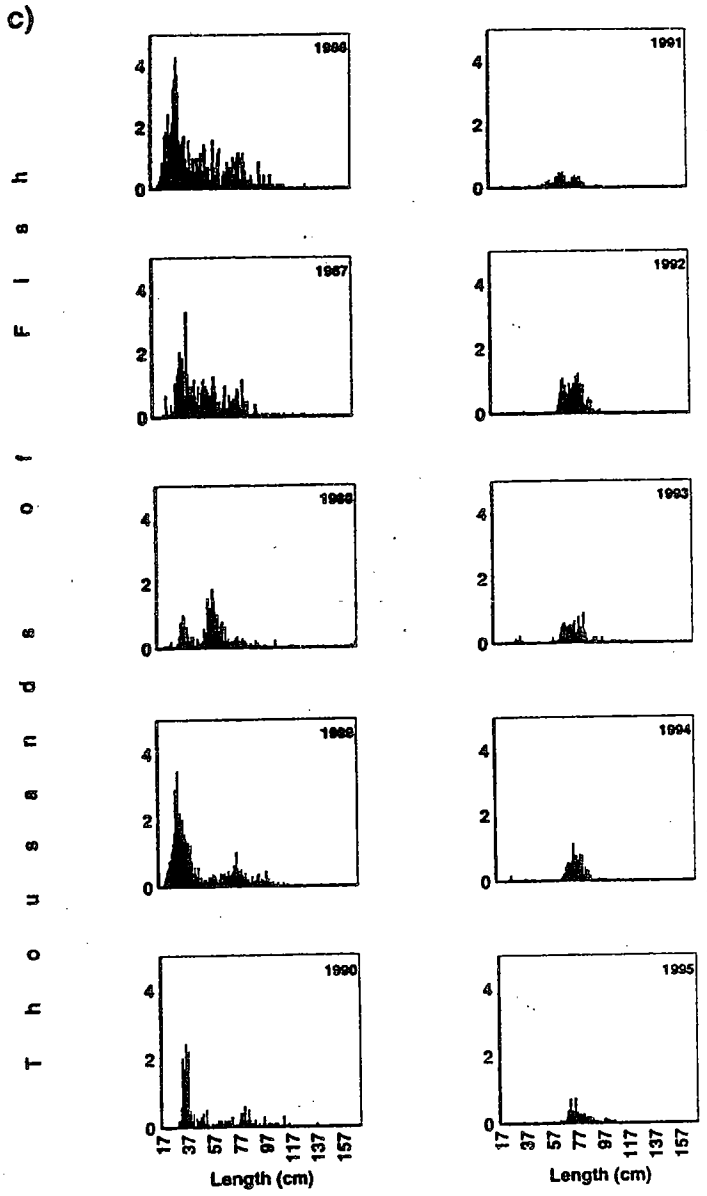

Figure 3c. Estimated harvest of Gulf of Mexico greater amberjack stock by size category and fishery - by headboat from 1986-1995.

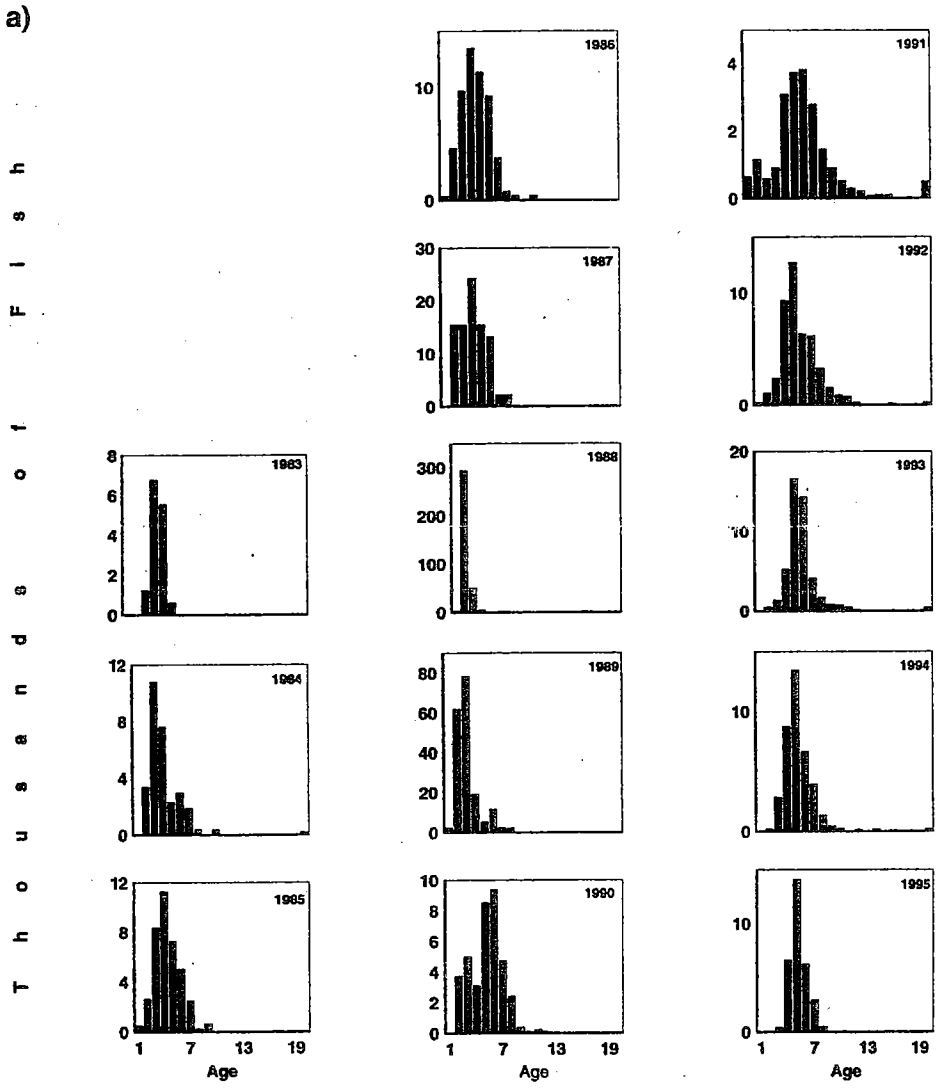

Figure 4a. Estimated catch at age of the for the Gulf of Mexico greater amberjack stock - landed commercially from 1983 - 1995.

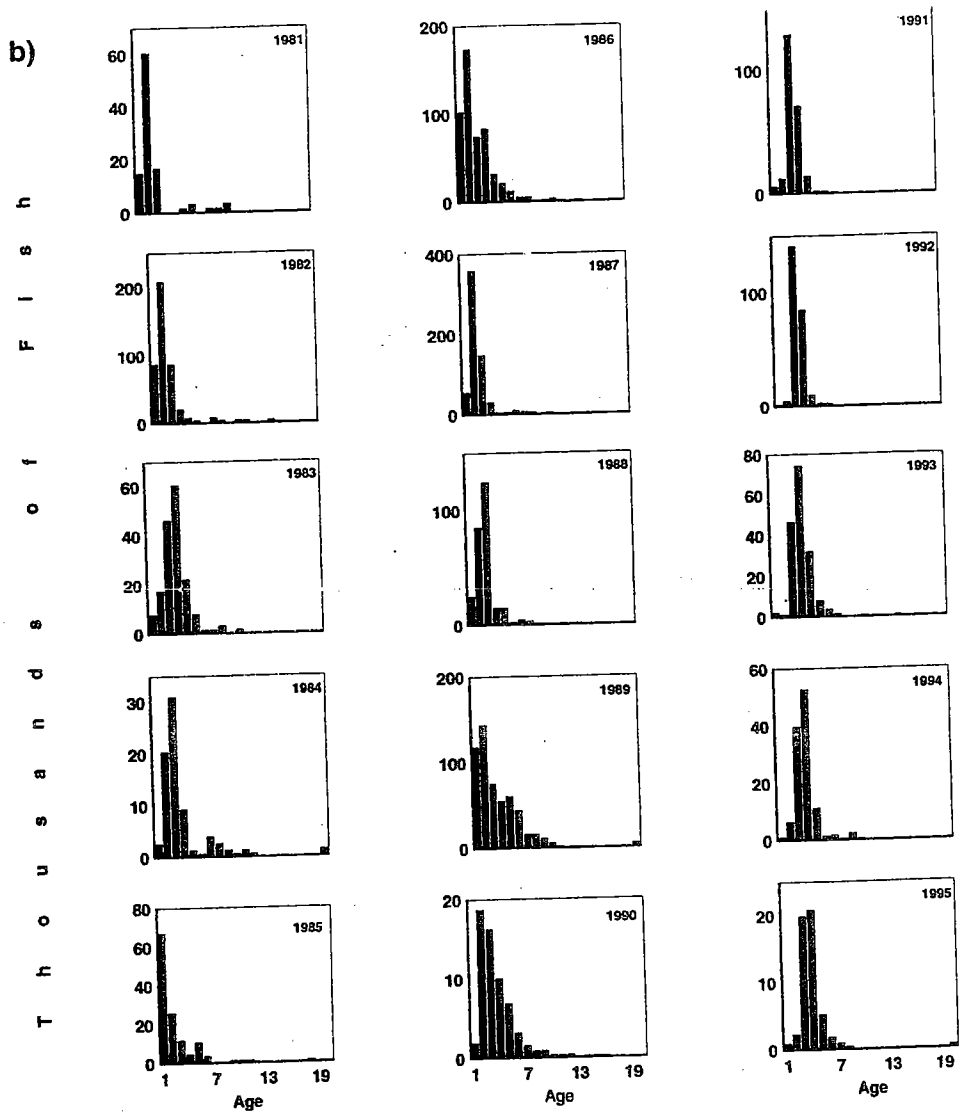

Figure 4b. Estimated catch at age of the for the Gulf of Mexico greater amberjack stock - harvested recreationally from 1981 - 1995.

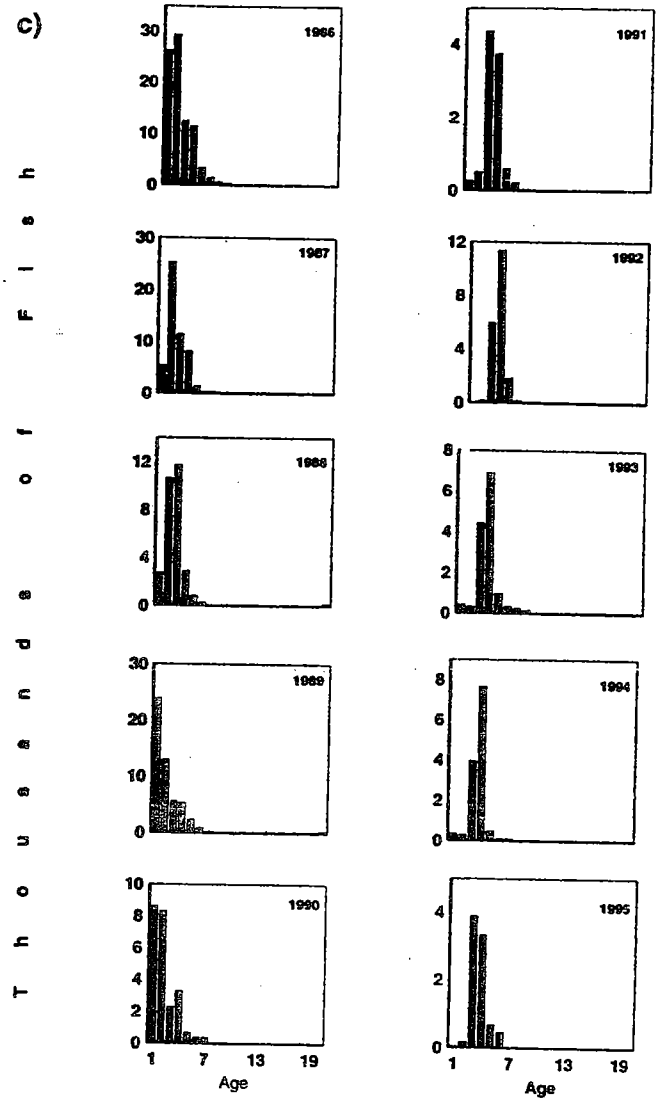

Figure 4c. Estimated catch at age of the for the Gulf of Mexico greater amberjack stock - caught from headboats from 1986 - 1995.

Each of the separate CPUE data sets was scaled to their own mean prior to fitting to the VPA. The catch at age data used in the ADAPT VPA (Table 2) included only the years 1987 through 1995 because prior to 1987 the catch at age data was considered incomplete.

In the initial ADAPT VPA trial runs, the parameters estimated by the model were the abundance at the beginning of 1995 for ages 4, 5, 6, and 7+. Fishing mortality of ages 7+ was set equal to the fishing mortality of age 6 for all years and the assumption of equal selectivity on ages 7+ in the last year of catch (1995) was made. Natural mortality, M, was set at 0.3 and assumed constant across age. As described by Powers and Restrepo (1992), in each of the VPA fits, iterative re-weighting was done in which the **LS** estimation was iterated with weights on each index being adjusted each iteration according to the variance in the estimation represented by the index. This procedure has been used by some researchers because of the large variability in the indices and use of re-weighting of the individual indices within the LS minimization is considered to yield better statistical properties. Six additional runs were made to obtain some information about the uncertainty in the VPA, by changing the input parameters (i.e., the stock sizes of the ages to be estimated) and revising the MRFSS and logbook CPUE abundance indices. In these additional runs the number of and the identity of the specific age groups to be estimated was altered and the revised catch at age data file was used.

Gulf of Mexico greater amberjack ADAPT VPA tuning results are presented in Figure 5a-c and Table 3. The model results are robust and show reasonably similar patterns between runs in the estimation of abundance of age one recruits up to the last three years in the analysis (Figure 5a), of adult fish abundance (Figure 5b), and also in the estimation of fishing mortality (Figure 5c). This observation is not unexpected as VPA estimates are considered more reliable as the model progresses back in time because of statistical properties associated with convergence.

The ADAPT VPA results suggest that greater amberjack adult population size was larger in the late 1980's than from 1990 through 1992, the decline in adult stock beginning in 1989 about the point in time as the explosive increase in commercial landings was reported. In addition, this corresponds to the point in time when estimated recreational catches show declining trends. Stock sizes of adults, ages 4+, ranged from about 350,000 fish to 400,000 fishes from 1987 through 1989 and declined to about 200,000 fishes in 1990 (Figure 5b). The VPA results suggest fishing mortality on adults, age 4-7+, was highest in 1989, increasing from the 1988 level of 0.1 to about 0.8. Fishing mortality on adult fishes ranged from about 0.2 to 0.4 from 1990 through 1992 (Figure 5c). Recruitment was stable from 1987 through 1992 at about 1,000,000 fishes (Figure 5a). Spawniing Potential Ratios (SPR) were calculated for each ADAPT

VPA run using the average fishing mortality rate for 1993 and 1994. The 1994 dynamic un-weighted SPR's ranged from 34% to 42% across all the amberjack VPA trials (Table 3).

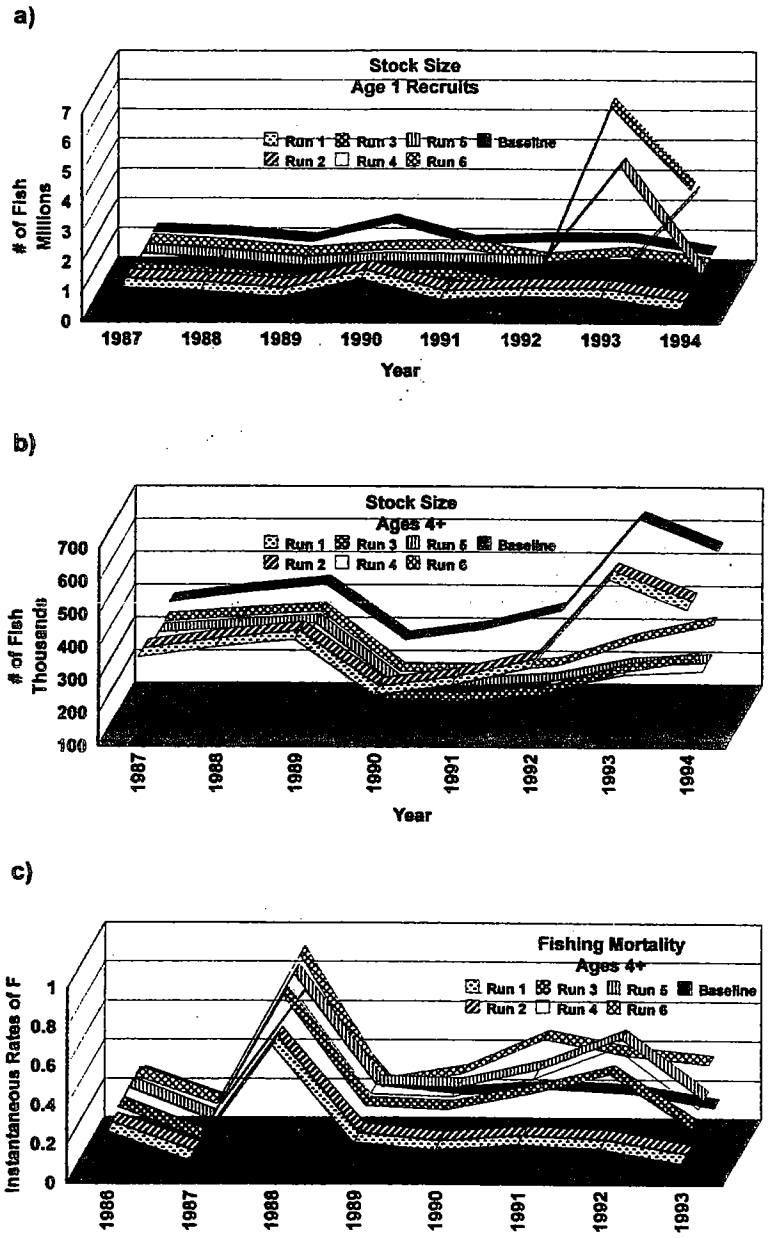

Figure 5. ADAPT VPA results for the Gulf of Mexico greater amberjack stock; **a)** estimated stock size of age 1 recruits, 1987 - 1995, **b)** estimated stock size of adult fish, age 4-7+, 1987 - 1995, and **c)** estimated fishing mortality of adult fish, age 4-7+, 1987 - 1995.

Table 2. Estimated harvest Gulf of Mexico greater amberjack stock by commercial, recreational (charter, private, shore) and headboat fishers by year and age. Tabled data reflects corrections made from values reported by McClellan and Cummings (1996).

	Calender Year								
Age	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	61,630	31,110	145,199	10,602	7,355	2,127	2,638	1,602	1,009
1	400,352	390,402	219,094	30,838	14,171	6,347	2,345	6,929	2,643
2	175,539	187,369	159,829	23,597	134,476	149,611	52,572	46,579	24,239
3	63,324	23,476	79,886	16,511	75,990	105,923	86,640	69,218	30,817
4	21,589	17,554	68,264	16,138	18,135	24,722	49,698	25,214	19,998
5	19,076	3,529	56,727	12,990	3,118	9,243	22,701	8,327	8,652
6	13,291	6,961	19,437	6,726	5,904	8,586	8,069	5,904	3,911
7+	21,856	11,212	45,343	6,924	9,665	11,894	7,958	7,117	1,666
1-3	639,215	601,247	458,809	70,946	224,637	261,881	141,557	122,726	57,699
4-7+	75,812	39,256	189,771	42,778	39,822	54,445	88,426	46,562	34,227
5-7+	54,223	21,702	121,507	26,640	21,687	29,723	38,728	21,348	14,229
Total	776,657	671,613	793,779	124,326	268,814	318,453	232,621	170,890	92,935

Table 3. ADAPT VPA results for the Gulf of Mexico greater amberjack stock.
nc = no model convergence for this age
* = catch at age data corrected from that reported in McClellan and Cummings(1996),
** = catch at age input data corrected from that reported in McClellan and Cummings (1996) and revised MRFSS standardized CPUE index used.

Run ID	Estimated Ages	Residual Sum of Squares	CV of Stock Size (Estimated Ages)	F (Ages 4+) 1983-1993
Baseline	4, 5, 6, 7+	0.3205	0.24, 0.29, 0.35, 0.35	0.28
1*	4, 5, 6, 7+	0.3058	0.24, 0.29, 0.34, 0.34	0.26
2**	4, 5, 6, 7+	0.3077	0.24, 0.29, 0.35, 0.34	0.27
3**	4, 5, 6	0.5549	nc, 0.30, 0.39	0.39
4**	3, 4, 5	0.6745	nc, 0.34, 0.36	0.41
5**	2, 3, 4, 5	0.6656	nc, 0.35, nc, 0.49	0.41
6**	4, 5, 6	0.4465	0.26, 0.32, 0.30	0.43

Run ID	F (Ages 4+) 1989	F (Ages 4+) 1994	SPR (Unweighted) 1994
Baseline	0.70	0.11	0.34
1*	0.71	0.11	0.42
2**	0.71	0.11	0.34
3**	0.86	0.19	0.35
4**	0.88	0.24	0.34
5**	0.88	0.24	0.34
6**	0.85	0.17	0.36

DISCUSSION

Parrack (1993) documented the historical trends in commercial and recreational landings and CPUE, mean length and weight for the Gulf of Mexico greater amberjack stock, updating Goodyear's (1988) study. McClellan and Cummings (1996) and Cummings and McClellan (1997) extended the Parrack (1993) fishery catch, landings, size, and CPUE database through 1995, developed standardized abundance trends, and estimated total numbers caught for the combined fisheries.

The studies of Parrack (1993) and McClellan and Cummings (1996) documented the increases in commercial landings of greater amberjack off the west coast of Florida and off Louisiana between 1980 and 1990. Hook and lines were the most common gear however, significant catches of greater amberjack by bottom longliners occurred in the middle 1980's off Louisiana. Dramatic increases in total landings occurred from 1983-1988 with declines of about 51% in 1990, and subsequent landings declines again since 1993. Estimated commercial CPUE was stable from 1992 through 1994 and increased slightly from 1994 to 1995.

Significant declines in Gulf of Mexico recreational greater amberjack catches were documented, beginning in 1989 in all recreational sectors. The declining recreational catch trend is complicated by increases in observed average size in some years and by the large variability in estimated recreational catch. Declines in recreational CPUE from 1991 through 1994 may suggest abundance declines. Similar declines were not observed in headboat CPUE although, declining catches were observed. A shift in headboat fishing effort to other species may suggest one explanation for the decline in catches stable CPUE.

The status of the Gulf of Mexico greater amberjack stock was first evaluated using the maximum likelihood population analysis model, Simple Likelihood Model (SLM) (Parrack, 1990; 1993). That study showed total abundance was variable and imprecise over the time period 1986 - 1991 and fishing mortality averaged about 0.3 over the entire period and declined in 1990 by about one half. However, size information was needed in the model to estimate stock abundance of adults and of recruits, and the time series of size trends was limited because of incomplete bio-statistical sampling.

Bio-statistical sampling was less than 1% by number particulary prior to 1987 (Cummings and McClellan, 1997), therefore the ADAPT VPA stock status analyses only included the years after 1987. Several years in the commercial length data show truncated distributions (1983, 1987, 1988) suggesting some bias may have occurred in commercial sampling (Figure 3a). The 1992 through 1995 commercial catch at length distributions show that some landed fish were below the 36 inch (91 cm) FL minimum size limit. The recreational catch at length and age distributions suggest that from 1993 - 1995 a

portion of the total recreational harvest was also below the minimum, 28 inch (71 cm) FL size (Figure 3b).

Results presented from these ADAPT VPA analyses provide the first quantitative information on the level of fishing mortality and stock size trends on the Gulf of Mexico greater amberjack stock in the late 1980's. The results are consistent between multiple analyses. Fishing mortality and adult stock size was higher during the late 1980s than 1995. This observation supports the observation of some decline in abundance of large fish by recreational anglers in the early 1990's. The declining trends in recreational catch and commercial landings alone, however, do not support the concern about dramatic declines in abundance. In addition, relative abundance as measured from CPUE either indicated a stable abundance or increasing abundance and the ADAPT VPA results suggest stable fishing mortality from 1992 through 1994. Trends in abundance as measured from commercial vessels and logbook data in this study are temporally limited, beginning only in 1992. Commercial CPUE data from the Florida Department of Environmental Protection Program (FDEP) that extends back to 1987 could be evaluated to corroborate these trends and also to extend the CPUE abundance series back in time. The catch and biological sample do not allow the abundance of greater amberjack to be quantified prior to 1987. In addition, after 1992 the fishery dependent data do not index abundance of commercially caught fish less than 28 inch (71 cm) FL or recreationally caught fish less that 36 inch (91 cm) FL because of minimum size rules implemented for greater amberjack in 1990.

Current federal fishery management guidelines for Gulf of Mexico reef fish stocks define overfishing as occurring below SPR_{30}. The ADAPT VPA results of catch and biostatistical data through 1995, suggest the Gulf of Mexico greater amberjack stock is not overfished. Simulation studies of changes in SPR given changes in minimum sizes (Legault, 1997) indicated that at fishing mortality levels near those from this study, gains in SPR were possible, however increases in fishing mortality could reduce any potential gains. Increases in fishing mortality could occur through shifts in commercial effort between species, through increasing number of recreational anglers, or shifts in recreational angler target species. Releases of undersized fish which do not survive would also result in higher fishing mortality rates and increases in the selectivity of younger fish. Subsequent impacts could include increasing catches, smaller stock sizes, and reductions in spawning potential ratios.

Management options in effect as of June 1998 (DOC, 1998) are size limits of 28 inches (71 cm) FL for persons subject to bag limits of one fish per day (recreational fishers) and 36 inches (91 cm) FL for those not subject to bag limits (commercial fishers). Spawning season restrictions are in effect from March through May for commercial fishers, with recreational size and bag limits

in effect. Observations of increased length and the shift in the catch composition to older fish in both the commercial and recreational greater amberjack fisheries reflect size limits enacted in 1990 and provide qualitative support that the recreational and commercial minimum size limits have been effective in management of this species.

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